

RESEARCH ARTICLE

Minimal trauma hip fracture hospitalisations among older Indigenous and non-Indigenous Australians: A retrospective population-based cohort study

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Abstract

Objectives: To compare minimal trauma hip fractures (MTHF) between older Indigenous and non-Indigenous Australians.

Methods: Epidemiological study of retrospective New South Wales hospitalisation data (2005–2016) for MTHF among Indigenous and non-Indigenous Australians over 40 years of age.

Results: Estimated age-standardised rates of MTHF were lower among Indigenous Australians than non-Indigenous Australians (142.2 vs. 161.7 per 100,000) with a direct standardised rate ratio of 0.887 (95%CI 0.78–0.99, $p = 0.031$). However, for both male and female Indigenous Australians, MTHF occur at a younger age than in non-Indigenous Australians (age 40–74: 52% vs. 19%, $p < 0.001$). Proportions of MTHF are higher among women and were almost double among rural Indigenous Australians compared with rural non-Indigenous Australians (59% vs. 31%, $p < 0.001$).

Conclusions: New South Wales Hospitalisation data showed that estimated age-standardised rates of MTHF appear lower among Indigenous Australians than in non-Indigenous Australians but also occur at a younger age for Indigenous people. MTHF are more common among rural Indigenous Australians and women.

KEYWORDS

Indigenous, Rural, Older People, Aged, Fracture, Falls, Bone, Hospitalization, Hospitals, Public / statistics & numerical data, Retrospective Studies

1 | INTRODUCTION

Indigenous Australians are more likely to have an osteoporotic hip fracture than non-Indigenous Australians.^{1–3} However, New South Wales (NSW) data found that Indigenous Australians had fewer fall-related hip fractures than non-Indigenous Australians.⁴

There is conflicting evidence about the bone health of Indigenous Australians. Indigenous Australians are reported to experience minimal trauma hip fractures (MTHF) at a younger age.¹ This contrasts with the findings by Macintosh et al., who reported that Indigenous females are on average 8 years older than non-Indigenous Australians when they sustain MTHF.⁵ However, the

study consisted of only 323 admissions and included only 15 Indigenous people.⁵ A 2017 international systematic review found that the fracture rates were lower for Indigenous persons, except in Canada and Australia. The authors age-standardised the incident fracture rates per 100,000 person-years. The Australian findings were based on two relatively old papers and small sample sizes from 2001⁵ to 2013.^{2,3} There is a need for empirical data with larger sample sizes to further explore MTHF in Indigenous Australians.

A hip fracture resulting from minimal trauma is most likely due to osteoporosis and can be a useful indicator of general health in the ageing population.⁶ MTHF can be seen as a proxy clinical measurement of bone health. The health of Indigenous Australians is often reported as poorer than their non-Indigenous counterparts, particularly in relation to chronic diseases.^{7,8} However, Indigenous peoples also have higher levels of obesity than other Australians⁹ and obesity has been shown in meta-analysis to be protective of hip fractures,¹⁰ which equally could suggest that Aboriginal people are less likely to sustain a hip fracture.⁴ Potentially, differences in the MTHF rates could be explained by genetic differences in bone density or in the anatomical geometry of the proximal femur. It is therefore important to determine whether MTHF in Indigenous Australians occur at a younger age compared with non-Indigenous Australians. This may also inform public health prevention measures and acute and long-term treatment. This is especially pertinent given our ageing population. Government initiatives aim to improve the healthcare of Indigenous Australians, yet barriers still exist.⁷ Rurality is one such barrier that affects all Australians, as access to healthcare for the management of chronic diseases is lower compared with metropolitan areas.^{7,8,11}

The primary aim of this paper was to determine the rate of MTHF of Indigenous Australians compared with non-Indigenous Australians in NSW and highlight potential differences such as age, gender and rurality.

2 | METHODS

2.1 | Study design

The study design is an epidemiological study of retrospective data on hospitalisations within NSW for minimal trauma hip fracture among Indigenous and non-Indigenous Australians over 40 years of age from 2005 to 2016. The data are restricted to patients admitted to NSW public hospitals.

Policy Impact

With keeping the limitations of analysing hospitalisations data in mind, increased awareness of MTHF among specifically younger and rural Indigenous Australians and women is warranted. The findings reinforce the need for ongoing existing public health education that supports healthy bones such as exercise and healthy diet.

Practice Impact

Targeted support is needed in terms of prevention and treatment for younger and rural Indigenous Australians and women, to improve bone health and reduce MTHF. Data linkage studies are required to explore fracture rates and bone mineral density in Indigenous Australians.

2.2 | Case selection

The NSW Australian Patient Data Collection (APDC) codes data according to the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification.¹² MTFHs are often considered more common in older people. Given the shorter life expectancy of Indigenous Australians, 40 years of age was used to allow for the potential capture of Indigenous people who could fracture their hip earlier in life. Furthermore, people were included if they were admitted to NSW hospitals with an MTHF (S72.0 to S72.2 codes) and likely Minimal Trauma (using principle external cause W codes W00, W01, W03-W08, W18, W19 (6)) (Appendix S1).

As we were unable to obtain linked data for the study period, it was possible for a single patient hospital admission to result in multiple admission events in the same or at different hospitals due to clerical data entry. It was important to use a single hospital admission for each patient. A filtering process was developed to screen for and minimise these potentially duplicated records. There were 107883 admissions between 2005 and 2016; after the filtering process 40,383 admissions were excluded and 67,500 admissions were included. See Appendix S2 for further details of exclusions and a flow diagram in Figure 1 of inclusion and exclusion criteria.

2.3 | Outcome measures

The APDC dataset consisted of demographics, hospital admission data, diagnoses and procedures, and Indigenous

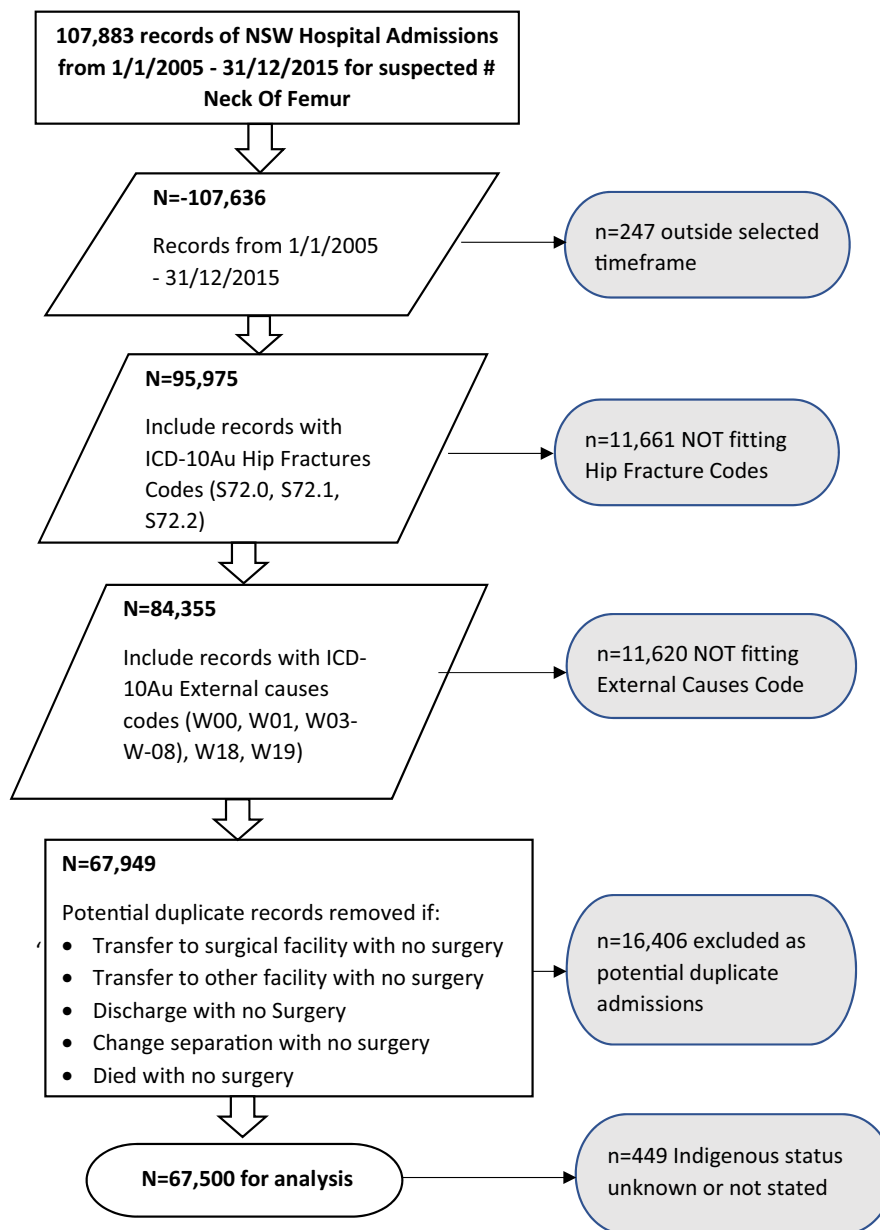


FIGURE 1 Flowchart of exclusion and inclusion criteria of hospital records

status. On admission, people were asked by hospital staff whether they self-identify as Aboriginal or Torres Strait Islander peoples, both or neither. Nonresponses or 'not stated' responses were excluded ($n = 449$) after filtering. People who identified as Aboriginal or Torres Strait Islander peoples or both were included as Indigenous Australians. Age was categorised into 5-year brackets in line with other NSW-based research^{4,11} and as recommended by the Australian Institute for Health and Welfare (AIHW) for estimating age-standardised rates.¹³

The patient's residential address was used to provide the 2011 Local Government Area and 2011 Statistical Area code SA2¹⁴ for each admission. The SA2 code was used to determine two categories of rurality. 'Urban' was defined as Major Cities and 'rural' combined the other categories

from the Remoteness Areas of Australia 2011 classifications (Major Cities, Inner Regional, Outer Regional, Remote and Very Remote).¹⁵

The Charlson Comorbidity Index, calculated from secondary diagnoses, provided a measure of comorbidity. A higher score may result in increased mortality or increased resource use. Scores were categorised into 0, 1–3, 4–6 and more than 6.

Given the variance in Indigenous population data, an age-standardisation process was used to allow direct comparison of data. NSW population numbers by age, Indigenous status and gender from the Australian Bureau of Statistics (ABS) Census data for the period of the data collection (interpolated for inter-census years) were used to determine the denominator of person-years for crude

and standardised rates. The 2011 Australian population numbers by five-year age categories were used for age-standardisation calculations.

2.4 | Statistical methods

Descriptive statistics (numbers and percentages) were used to describe the demographic and MTHF characteristics of the study population by Indigenous status. Chi-square tests of association for differences between Indigenous and non-Indigenous Australians for proportions were undertaken. Age-specific minimal trauma fracture rates were calculated by dividing the number of hospital admissions in each 5-year age bracket by the NSW population in that age group by Indigeneity. The age-specific rates and rate ratio comparing the rates for Indigenous and non-Indigenous Australians are reported (with 95% confidence intervals). The Australian standard age population from 2011 Census data was used to determine the impact of the reference population on directly standardised MTHF rate estimates per 100,000 people. SAS/STAT version V14.1 (SAS Institute Inc) was used to conduct the statistical analyses.

2.5 | Ethics statement

The study was approved by the NSW Population and Health Service Research Ethics Committee (2018/ETH00736) and the Aboriginal Health and Medical Research Council Human Research Ethics Committee (1372/18).

3 | RESULTS

Out of the total 67,500 hospitalisations for MTHF, 0.57% (388/67,500) were Indigenous Australians.

3.1 | Demographics

The majority of MTHF were among women (68% Indigenous Australians vs. 73% among non-Indigenous Australians, $p < 0.037$) (Table 1). MTHF occurred at a younger age for Indigenous Australians compared with non-Indigenous people: 52% of Indigenous Australians aged between 40 and 74 years had MTHF compared with 19% of non-Indigenous Australians ($p < 0.001$). Significant differences were found for the Charlson Comorbidity Index ($p = 0.047$), with Indigenous Australians having higher levels on the Charlson Comorbidity Index. The proportion of MTHF in rural areas was almost double

among Indigenous Australians versus non-Indigenous Australians (59% vs. 31%, $p < 0.001$).

Table 2 shows that higher proportions of female Indigenous Australians have MTHF hospitalisations above 70 years of age when compared to male Indigenous Australians. Of those aged 80 years or older, 38% of Indigenous women sustained MTHF compared with only 16% of Indigenous men. Similarly, higher proportions of non-Indigenous women have MTHF hospitalisations compared with non-Indigenous men, but this starts at a later age for non-Indigenous women, namely above 80 years of age (74% female non-Indigenous vs. 64% male non-Indigenous). Additionally, the proportion of MTHF for non-Indigenous women aged 80 years and over is double the proportion of Indigenous women (74% non-Indigenous women vs. 38% Indigenous women).

3.2 | Characteristics of minimal trauma fractures

Table 1 showed that there is no statistically significant difference between neck of femur fractures (NOF) among hospitalised Indigenous Australians compared with non-Indigenous Australians (46% vs 52%, $p = 0.056$) and pertrochanteric femur fractures (PTFF) (48% vs 43%, $p = 0.056$). Further analyses revealed no statistically significant difference in these proportions between Indigenous and non-Indigenous Australians for urban residents, (NOFs: 48% vs 51% and PTFF: 47% vs 44%, $p = 0.734$). However, for rural residents the differences between Indigenous Australians and non-Indigenous people demonstrated significance (NOFs: 45% vs. 55% and PTFF: 50% vs 40%, $p = 0.008$). The proportions of MTHF occurring at home was higher for Indigenous Australians (57% vs 49%) but lower in residential aged care facilities (16% vs 32%, $p < 0.001$).

3.3 | Age-standardised rates of Minimal Trauma Hip Fractures (Table 3)

Table 3A shows that the age-specific rate ratio of sustaining MTHF for Indigenous Australians is statistically significantly higher than for non-Indigenous Australians for ages 45 to 59 and 70 to 74. For example, among people aged 45–49 years, the rate of MTHF per 100,000 people is 11.86 for Indigenous peoples compared with 4.26 for non-Indigenous people. This indicates that Indigenous peoples aged between 45 and 49 years have almost three times the rate of sustaining MTHF compared with non-Indigenous people (rate ratio: 2.79 [95% confidence interval: 1.65–4.69]). However, this pattern reverses for people

TABLE 1 Demographics and characteristics of minimal trauma hip fractures (MTHF)

	Indigenous <i>n</i> = 388		Non-indigenous <i>n</i> = 67,112		<i>p</i> -value
	<i>n</i>	%	<i>n</i>	%	
Female gender	263	67.8	48,679	72.5	0.037
Age group (in 5-year groups)					
40–44	6	1.5	153	0.2	<0.001
45–49	15	3.9	247	0.4	
50–54	25	6.4	538	0.8	
55–59	31	8.0	1030	1.5	
60–64	27	7.0	1620	2.4	
65–69	40	10.3	2735	4.1	
70–74	58	14.9	4568	6.8	
75–79	66	17.0	8605	12.8	
80–84	58	14.9	14,445	21.5	
> = 85	62	16.0	33,171	49.4	
Charlson comorbidity index					
0	305	78.6	55,243	82.3	0.047
1–2	63	16.2	9657	14.4	
3–5	17	4.4	1607	2.4	
> = 6	3	0.8	605	0.9	
Geographical area of residence (SA2 based)					
Metro-Urban	153	39.4	45,295	67.5	<0.001
Rural	230	59.3	20,629	30.7	
Interstate	5	1.3	1188	1.8	
Site of fracture					
Neck of femur	179	46.1	35,050	52.2	0.056
Pertrochanteric	187	48.2	28,616	42.6	
Subtrochanteric	22	5.7	3446	5.1	
Mechanism of Fall					
Minimum trauma—same level	244	62.9	45,035	67.1	0.078
Minimum trauma—furniture or unspecified	144	37.1	22,077	32.9	
Place of injury					
Home	222	57.2	32,699	48.7	<0.001
Aged care facility	62	16.0	21,430	31.9	
Health Services Area	9	2.3	1893	2.8	
Public Area	40	10.3	5439	8.1	
Other/unspecified	55	14.2	5642	8.4	

aged 80 years and over in that non-Indigenous people aged 80 years and over have higher rates of MTHF, the age group where nearly 50% of MTHF occur. This latter finding was not statistically significant for the age group 80–84 years of age. However, it was significant for people aged 85+ with the rate of MTHF per 100,000 people being 1248.94 for Indigenous peoples compared with 2028.94 for non-Indigenous people. This indicates that Indigenous peoples aged over 85 years are less likely to sustain MTHF

compared with non-Indigenous people (rate ratio: 0.62 [95% confidence interval: 0.48–0.79]).

Table 3B shows that using directly standardised estimated rates based on the Australian Standard Reference population from the 2011 Census 16 that the estimated standardised rates of MTHF were significantly lower among Indigenous Australians than non-Indigenous Australians (142.2 per 100,000 vs. 161.7 per 100,000) with a direct standardised rate ratio of 0.88 ($p = 0.031$).

TABLE 2 Minimal Trauma Hip Fractures hospitalisations by age by gender and Indigenous Status*

Age (years)	Indigenous Australians				Non-indigenous Australians			
	Female		Male		Female		Male	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
40–49	6	2.3	15	12.0	190	0.4	210	1.1
50–59	30	11.4	26	20.8	913	1.9	655	3.6
60–69	40	15.2	27	21.6	2774	5.7	1581	8.6
70–79	87	33.1	37	29.6	9001	18.5	4172	22.6
80+	100	38.0	20	16.0	35,801	73.5	11,815	64.1
Total	263		125		48,679		18,433	

* $p < 0.001$.**TABLE 3** Age-specific rates and age-standardised minimal trauma hip fracture hospitalisations of people aged 40 years and over, New South Wales, 2005–2016 by age and Indigenous people status (A) Effect Estimates (Rate Multiplier = 100,000) by Age in Five-Year Categories and Rate Ratios with 95% Lognormal Confidence Limits. (B) Directly Standardised Rate Estimates (Rate Multiplier = 100,000) 2011

(A)								
Age (years)	Indigenous	Non-Indigenous	Rate ratio	95% lognormal confidence limits				
40–44	4.29	2.58	1.66	0.73	3.76			
45–49	11.86	4.26	2.79	1.65	4.69			
50–54	22.96	9.70	2.37	1.59	3.54			
55–59	36.20	19.94	1.82	1.27	2.60			
60–64	43.85	36.22	1.21	0.83	1.77			
65–69	94.26	73.06	1.29	0.94	1.76			
70–74	219.11	155.17	1.41	1.09	1.83			
75–79	420.77	363.66	1.16	0.91	1.47			
80–84	700.74	811.69	0.86	0.67	1.12			
85+	1248.94	2028.94	0.62	0.48	0.79			
(B)								
	Study population			Reference population		Standardised rate		
	Observed events	Population time	Crude rate	Expected events	Population time	Estimate (standard error)	95% Confidence limits	
Indigenous	388	620,372	62.5	175,329	123,276,576	142.2 (8.43)	125.7	158.8
Non-Indigenous	67,112	39,388,237	170.4	199,341	123,276,576	161.7 (0.62)	160.5	162.9
Using 2011 Australia as standard population								
Rate effect estimates (Rate multiplier = 100,000)								
Indigenous	Non-Indigenous	Rate ratio	95% lognormal confidence limits		Log rate ratio	Standard error	Z	Pr > IZI
142.2	161.7	0.8795	0.782859	0.988169	−0.1284	0.0594	−2.16	0.0308
Using 2011 Australia as standard population								

The bold indicates statistically significant different values.

4 | DISCUSSION

Age-specific MTHF rates for Indigenous people were higher in the younger age groups (45–59 and 70–74 years)

and lower for people aged 85 years and over compared with non-Indigenous people. For example, the rate of MTHF per 100,000 people is 22.96 for Indigenous peoples aged 50–54 years, compared with 9.70 per

100,000 for non-Indigenous people. This suggests that Indigenous peoples aged between 50 and 54 years have two and half times the rate of sustaining MTHF compared with non-Indigenous people (rate ratio: 2.37 [95% confidence interval: 1.59–3.54]). Nonstandardised data also indicated that MTHF proportions were higher for Indigenous Australians aged below 79 years but lower for those 80 years and older compared with non-Indigenous Australians, for both men and women. Presumably, this finding reflects the age structure of the Aboriginal population. Notably, the age-specific rates are lower in oldest old (≥ 85 years) among Indigenous people compared with non-Indigenous people. This could potentially indicate the survivor effect in older Aboriginal people. Overall, Indigenous Australians aged 40 years and over have a lower age-standardised rate estimate of MTHF compared with non-Indigenous Australians, when using Australian census population data from 2011.

Wong et al. investigated the MTHF of Indigenous Western Australians between 1999 and 2009.² In our study, 31% of Indigenous Australians aged 80 years and over experienced MTHF versus 71% of non-Indigenous people, with Wong et al. demonstrating similar proportions: 27% versus 67%. Compared with our study, they used 2001 Australian census data for age-standardisation and found higher MTHF rates among Indigenous adults.² There are several potential reasons for this difference. It is noted that 85% of Indigenous people in Wong's study lived rurally versus only 59% in our study. Wong reported that age-standardised MTHF rates were much higher among rural Indigenous people than rural non-Indigenous people. Furthermore, lower MTHF age-standardised rates were reported among urban populations.² A Queensland study found that Indigenous females had lower MTHF rates and sustained them at an older age.⁵ Lukaszyk et al., using 2003–2012 NSW data, found that fall-related fracture injuries as a group, and hip fractures individually, were lower for Indigenous Australians, which aligns with our study findings. The major injury type for Indigenous patients was a nonfracture injury to the head or neck, whereas non-Indigenous patients sustained hip fractures.⁴

Indigenous females aged below 79 years have proportionally more MTHF than non-Indigenous females. The proportion of MTHF for non-Indigenous women aged 80 years and over is double the proportion of Indigenous women. However, of Indigenous Peoples aged 70 years and above, females experience twice as many MTHF as Indigenous men. In contrast, Indigenous males have a higher rate of MTHF below 70 years of age and then decrease sharply after 80 years of age. This may be due to the shorter life expectancy of Indigenous males.

Whilst the Australian population is ageing and the actual number of hip fractures is increasing, hip fracture ratios over time are declining,⁶ which may suggest that current public health measures may be positively impacting at-risk groups.⁶ The Indigenous population is also growing. Indigenous Peoples represented 3% of the Australian population in 2016, increased from 2% in 2006.¹⁷ The number of people identifying as Indigenous is increasing. A 2010 AIHW report noted that 89% of Indigenous people were identified correctly in their hospitalisation records, with identification increasing by 8% in NSW public hospitals between 2005 and 2010.¹⁸ However, the report did not include persons aged below 18 years. Therefore, a 2013 AIHW report adjusted the original findings, with 88% of Indigenous people being correctly identified.¹⁹ Complete data collection and linkage improve Indigenous identification and the effect of public health measures.²⁰

Rural Indigenous Australians have a higher proportion of MTHF compared with urban Indigenous Australians. Additionally, the proportion of MTHF among rural Indigenous Australians is almost double that of their non-Indigenous rural counterparts. The long-term management of MTHF in rural communities is more difficult than with patients in urban areas. Rural chronic disease patients have limited access to medical facilities.²¹ Rural patients discharged from hospitals have limited resources and longer distances to travel, making access to rehabilitation, nursing homes and social support more difficult. The higher proportions of MTHF among rural and younger Indigenous Peoples may also be due to lower education and health literacy,²¹ especially around bone health, and decreased identification of osteoporotic risk factors and secondary prevention of osteoporosis amongst health professionals.²²

Rural (not urban) Indigenous Australians are more likely ($p = 0.008$) to sustain pertrochanteric femur fractures compared with non-Indigenous Australians, who are more likely to sustain neck of femur fractures. Elderly patients with moderate to severe hip osteoarthritis have a higher bone mineral density (BMD) of the neck of femur compared with patients without hip osteoarthritis.^{23,24} Variances in patient anatomy, specifically a wider femoral neck and a medial centroid hip geometry, are associated with an increase in hip osteoarthritis and femoral neck BMD.²⁵ McIntosh and Pearson⁵ argued that it is possible that the Indigenous population has a naturally higher BMD than the non-Indigenous people and that this protects them from osteoporotic fractures. Mapel-Brown et al. assessed the femoral neck BMD of Indigenous Australians using bone densitometry and found that femoral BMD was higher for Indigenous Australians compared with Caucasians, and remained higher in men after adjusting for lean mass.²⁶ Genetic anatomical differences may

reflect responses to loading resulting in hip osteoarthritis and its associated increased BMD, which can potentially explain the higher rate of pertrochanteric femur fractures and lower femoral neck fracture rates observed in rural Indigenous residents in our study. Further studies are required of BMD and related fracture rates in Indigenous Australians⁵ at a population level.²⁶

4.1 | Strengths and limitations

This study adds to the existing evidence of MTHF hospitalisations among Indigenous and non-Indigenous Australians in a large population-based cohort. Using large routinely collected datasets from public hospitals always has known limitations. Firstly, some patients may have had multiple records for the same admission. Formal data linkage with other known datasets was unfeasible; however, a case selection process was followed to reduce this bias. This should be taken into account when interpreting the study results. Secondly, there are known problems with the data quality of correctly identifying Indigenous Australian status. Bentley and colleagues identified that reporting of Aboriginal and Torres Strait Islander peoples in 2010 was reasonably high overall at 91%, but there remains room for improvement, especially in metropolitan areas.²⁷ The authors noted a 3% increase in improved reporting compared with 2007, although this was not statistically significant in this study. Therefore, the population is likely to be underestimated. However, this appears to be improving over time.^{18,19} Thirdly, the study did not account for potential confounders (e.g. hospital size). Fourthly, minimal trauma was defined by using external cause W codes.¹² Principal external cause codes can have measurement errors, which may impact the study findings. We therefore followed the procedure that was used by the AIHW to define minimal trauma.⁶ Fifthly, the 2011 version of SA2 was used to determine rurality; however, the data ranged from 2005 to 2016. Possible implications of changes in categorisation of SA2 over the study period may have occurred, but the data are all produced on the same boundaries for ease of comparability across years. Lastly, patients that were treated conservatively and died in hospital without surgery were excluded. Given the small numbers, they do not have a large impact on the study findings.

Age-standardisation has the strength of allowing improved comparisons between populations of different age structures. However, with the rapidly changing ageing demographics, the accuracy of this process will be dependent upon the standard population used. Given that this is an observational study, care should be taken if generalising the results beyond the study population.

5 | CONCLUSIONS

Hospitalisation data show that for Indigenous Australians minimal trauma hip fractures occur at a younger age for both men and women, but overall had a lower age-standardised MTHF rate than non-Indigenous people. The MTHF are more common among rural Indigenous Australians than rural non-Indigenous people. Rural Indigenous Australians are also more likely to sustain pertrochanteric fractures compared with non-Indigenous Australians, who are more likely to sustain neck of femur fractures.

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CONFLICTS OF INTEREST

No conflicts of interest declared.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the NSW Admitted Patient Data Collection. Restrictions apply to the availability of these data, which were used under license for this study.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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